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INTEGRATING SWOT AND AHP IN A PARTICIPATORY STRATEGY FOR DISSEMINATING FISHERIES PRODUCTIVITY INFORMATION IN SEGARA ANAKAN LAGOON, CILACAP REGENCY

Integrasi Analisis SWOT dan AHP dalam Strategi Partisipatif untuk Diseminasi Informasi Produktivitas Perikanan di Laguna Segara Anakan, Kabupaten Cilacap

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ABSTRACT

The Segara Anakan Lagoon (LSA) is a coastal region characterized by unique ecological features and a high level of biodiversity in its fishery resources. Functioning as the estuarine outlet of the Citanduy River Basin, the lagoon receives substantial freshwater inflow laden with high sediment loads. This natural dynamic, compounded by anthropogenic activities from surrounding communities, has led to ecological degradation manifested in declining water quality, reduction of the lagoon's water body, and increased nutrient accumulation, which in turn triggers eutrophication. Consequently, the fishery resource potential has diminished, adversely affecting the welfare of local fishing communities, as evidenced by a growing trend of occupational shifts from fishing to farming. This community engagement study, grounded in scientific research, aims to mitigate the rate of ecological degradation while promoting behavioral transformation toward a conservation-oriented mindset as a strategic measure to enhance the livelihoods of fishers. The methodology encompasses the development of thematic maps based on in situ ecological analyses, a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis to identify the strategic conditions of the LSA area, and the application of the Analytical Hierarchy Process (AHP) to establish solution prioritization. All quantitative data obtained were disseminated to the local community through Focus Group Discussions (FGDs). Community perception and participation were evaluated using structured questionnaires, with subsequent statistical analysis performed to test the validity and reliability of the instruments. Through this participatory approach, it is anticipated that information on high-potential fishery zones and viable ecological management solutions can be effectively communicated, thereby enhancing the adaptive capacity of coastal communities for sustainable resource governance.

Keywords: Coastal Ecological Management, Fisher Participation, Fishery Productivity, Segara Anakan Lagoon, SWOT-AHP Analysis

ABSTRAK

Laguna Segara Anakan (LSA) merupakan kawasan pesisir dengan karakteristik ekologis yang unik dan tingkat biodiversitas sumber daya perikanan yang tinggi. LSA berfungsi sebagai muara Daerah Aliran Sungai (DAS) Citanduy yang membawa aliran air tawar dengan beban sedimen tinggi. Kombinasi faktor alami tersebut, ditambah dengan aktivitas antropogenik masyarakat di sekitar LSA, telah menyebabkan degradasi ekologis berupa penurunan kualitas perairan, penyusutan badan air laguna, serta peningkatan akumulasi unsur hara yang memicu eutrofikasi. Dampak lanjutannya adalah penurunan potensi sumber daya perikanan yang berkontribusi terhadap penurunan kesejahteraan nelayan, yang ditandai dengan meningkatnya alih profesi masyarakat dari nelayan menjadi petani. Kajian pengabdian masyarakat berbasis riset ilmiah ini bertujuan untuk meminimalisir laju degradasi ekologis serta mendorong perubahan perilaku masyarakat menuju pola pikir konservasionis sebagai bagian dari strategi peningkatan kesejahteraan nelayan. Metode yang digunakan mencakup penyusunan peta tematik berbasis hasil analisis ekologis lapangan, analisis SWOT (*Strengths, Weaknesses, Opportunities, Threats*) untuk mengidentifikasi kondisi strategis LSA, serta penetapan skala prioritas solusi menggunakan pendekatan *Analytical Hierarchy Process* (AHP). Seluruh rangkaian data kuantitatif yang diperoleh disosialisasikan kepada masyarakat melalui *Focus Group Discussion* (FGD). Evaluasi persepsi dan partisipasi masyarakat dilakukan melalui pengisian kuesioner, yang kemudian dianalisis secara statistik untuk menguji validitas dan reliabilitas instrumen. Dengan pendekatan partisipatif ini, diharapkan informasi mengenai wilayah potensi perikanan yang tinggi serta alternatif solusi terhadap permasalahan ekologis di kawasan LSA dapat tersampaikan secara efektif, sekaligus meningkatkan kapasitas adaptif masyarakat dalam pengelolaan sumber daya pesisir secara berkelanjutan.

Kata Kunci: Laguna Segara Anakan, Partisipasi Nelayan, Pengelolaan Ekologis Pesisir, Produktivitas Perikanan, Analisis SWOT - AHP

INTRODUCTION

Cilacap Regency is a coastal area with an area of 225,361 km². Based on Law Number 27 of 2007 in conjunction with Law Number 1 of 2014 concerning the Management of Coastal Areas and Small Islands, coastal areas are defined as transition zones between terrestrial and marine ecosystems influenced by the natural processes of both. One of the important coastal areas in Cilacap Regency is the Segara Anakan Lagoon (LSA), which is geographically located at coordinates 7°35′–7°46′ South Latitude and 108°45′–109°01′ East Longitude, with an area of approximately 14,221.8 hectares and is located in Kampung Laut District. LSA is an area protected by Nusa Kambangan Island from the waters of the Indian Ocean and surrounded by river estuaries, so that the influence of land becomes very dominant due to the sedimentation process. In the west, the LSA receives tidal input from the Indian Ocean as well as high freshwater input from the Citanduy, Cibereum, and Cikonde rivers. Meanwhile, in the east, it receives short, narrow streams from the Sapuregel and Donan rivers (BPKSA, 2003). Naturally, the changes in its shape to date have occurred through various stages of environmental change. It is known that the LSA is not a stand-alone area; various factors influence its ecological changes (Ardli & Wolff, 2009; Carolita, 2005).

River flow carries a continuous supply of organic material that triggers the consolidation of coastal sediments, serving as a source of nutrients and forming the sediment's physical structure (Ardli & Wolff, 2009). Much of the LSA's water body is replaced by mangrove forests, which are then converted for various anthropogenic activities that impact the condition of the lagoon. Such water dynamics, if continued, create complexities in the water's physics, chemistry, and microbiology, and trigger the accumulation of nutrients. The levels are generally higher than in the open sea, resulting in higher productivity (Dahuri et al., 1996).

Beyond these ecological characteristics, the LSA has unique social characteristics.

The social characteristics of communities in the LSA area indicate the potential for strengthening local institutions through the existence of the Fishermen's Partners in Business Group, which regularly holds meetings to discuss various problems and formulate solutions collectively. This activity serves as an internal strength supporting the sustainability of coastal resource management. Based on this, community empowerment can be directed through a collaborative approach involving synergy between sectors. Such an approach is not only crucial for increasing community social capacity but also serves as a strategic step in integrating conservation interests with the well-being of coastal communities (Ostrom, 1990; Satria & Matsuda, 2004; Cinner & Aswani, 2007).

The sustainability of fisheries resources in the LSA is facing significant pressure due to a combination of natural and anthropogenic factors. One indicator is the significant decline in fishermen's catches, from an average of 20 kg per day to only 2–3 kg per day (Darmawan, 2024). This decline in productivity has a direct impact on the welfare of fishermen and has led to a shift in professions to farming. This phenomenon is exacerbated by the conversion of mangrove areas to agricultural land, which accelerates sedimentation and reduces the lagoon's water area due to freshwater influx from the surrounding watershed (Setyawan & Winarno, 2006; Soedjito et al., 2001; Rachmawati & Arifin, 2015).

Ecologically, the impact of this process causes a decrease in primary aquatic productivity, which is closely related to dissolved oxygen levels as a result of photosynthesis by phytoplankton, key organisms in the aquatic food chain (Tomas, 1997; Nybakken, 1998). Dissolved oxygen is strongly influenced by water quality, particularly by anthropogenic activities and nutrient input dynamics (Dsikowitzky et al., 2011). Salmin (2005) emphasized that dissolved oxygen is an important parameter in supporting the survival of aquatic biota because the concentration of oxygen gas dissolved in water, which is sourced from the photosynthetic activity of phytoplankton. The increase in nutrients due to cultural eutrophication and climate change has affected trends in phytoplankton communities (Yunev et al., 2007). Vadrucci (2006) strengthens the assumption that phytoplankton size characteristics are one indicator of anthropogenic pressure that certainly changes the environmental conditions of Mediterranean lagoons. Changes in environmental conditions in coastal areas are influenced by natural factors, such as freshwater inflow and sedimentation, as well as by anthropogenic activities through dynamic land-use changes (Pintado et al., 2007). Therefore, ongoing ecological degradation is feared to directly impact the potential decline of fisheries resources in the coastal waters.

Facing the complexity of this ecological degradation, a collaborative, cross-sectoral community empowerment approach is needed, involving local governments, local communities, the private sector, and academics. Several previous studies have highlighted the ecological conditions of coastal waters and the importance of community perception and participation in coastal resource management, as noted by Rachmawati & Arifin (2015), Setyawan & Winarno (2006), Dutton & Djohani (2000), Soedjito et al. (2001), Christie et al. (2005), and Armitage (2005). However, studies that explicitly integrate SWOT analysis and the Analytical Hierarchy Process (AHP) method in developing participatory, scientific-data-based management strategies at the fishing community level are still very limited. However, the integration of these two approaches can identify internal strengths and external opportunities in the region, while simultaneously involving the community in strategic decision-making. Based on this, this study aims to formulate a participatory fisheries productivity management strategy using the SWOT-AHP approach, the dissemination of which is expected to increase community understanding and involvement in maintaining the sustainability of the LSA ecosystem. In general, the integration of SWOT and AHP within a participatory framework can produce more adaptive, targeted, and sustainable management strategies. As a form of community service based on scientific research, this study aims to reduce the rate of ecological degradation by increasing community perception and participation, thereby strengthening sustainable LSA ecosystem governance and increasing the socio-economic resilience of coastal communities.

METHODS

Time and Place of Research

The research was conducted in May - June 2024 in a research-based community service activity carried out in the Segara Anakan Lagoon (LSA) area, Cilacap Regency, Central Java.

Methods

Strategies for resolving ecological issues in the LSA area were presented to the fishing community through Focus Group Discussions (FGDs) involving the Mitra Wira Usaha Fishermen Group as active participants. The forum presented quantitative data from scientific studies as a basis for participatory decision-making. The data presented included an analysis of changes in lagoon area based on interpretation of Landsat satellite imagery over a 38-year period (1978–2016), as well as the preparation of thematic maps of chlorophyll and nutrients (nitrogen and phosphate) based on in-situ ecological analysis.

Furthermore, to identify strategic factors influencing the LSA's ecological condition, a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was conducted, a systematic framework for identifying internal (strengths and weaknesses) and external (opportunities and threats) factors, which is highly useful in decision-making (Kotler & Keller, 2016). Based on the analysis results, the priority scale for solutions was determined using the Analytical Hierarchy Process (AHP) method, which allows for the decomposition of complex problems into more structured elements (Saaty, 1980). To evaluate the level of public perception and participation in the proposed strategies, a questionnaire was used as the primary instrument for primary data collection. This approach ensured that the strategy development process was not only based on scientific data but also accommodated active community involvement in maintaining the sustainability of the lagoon ecosystem.

The number of respondents was determined based on data from the Central Statistics Agency (BPS) (2016), which recorded a population of 17,230 people in the lagoon. This number was used as the basis for calculating the representative sample size for the questionnaire using the Slovin formula. With a precision of 10%, the number of respondents was 99.42, rounded up to 100. The validity of the questionnaire was then tested to determine the extent to which the questions were able to measure public perceptions of the impacts of eutrophication. According to Sugiyono (2009), an instrument is considered valid if it meets one of two criteria: (1) the Product Moment correlation coefficient (r count) > r table at a significance level of 5%, or (2) a significance value (sig) $\leq \alpha$. The results of the validity test on 10 questions showed significance values ranging from 0.000 to 0.001, which is below the α value of 0.01. Thus, all questionnaire items were declared valid at a significance level of 99%.

Next, a reliability test was conducted to measure the internal consistency of the instrument. The results showed a Cronbach's Alpha value of 0.371. Although this value did not meet the minimum reliability threshold based on the general criterion of $\alpha > 0.60$, further analysis was performed by comparing the r count to the r table. The instrument can be declared reliable if the r count > r table. It is known that the calculated r is 0.371, while the table r with degrees of freedom ($df = n - 2 = 148$) at a significance level of 5% is 0.1603. Because the calculated r > table r (0.371 > 0.1603), the questionnaire instrument is declared reliable (Suliyanto, 2005; Sujarweni, 2014).

RESULTS

Condition of the Segara Anakan Lagoon Land (LSA)

Table 1. Changes in Land Use in the LSA Area During the Time Period (1978 - 2016)

Land Use	Year					
	1978 (Ha)	1994 (Ha)	2001 (Ha)	2009 (Ha)	2011 (Ha)	2016 (Ha)
Lagoon	4,186.45	1,634.22	1,342.53	1,429.76	1,447.29	1,482.75
Mangrove	2,394.51	4,250.70	3,892.77	3,818.34	3,645.54	2,862.81
Non-Mangrove	6,193.89	3,455.10	3,123.97	3,447.14	1,277.52	4,718.16
Rice Fields	180.64	534.15	1,692.21	1,288.26	3,190.05	1,248.48
Dry Fields	2,271.37	2,159.19	3,179.16	3,947.58	4,155.84	2,375.64
Settlement	1,577.71	748.80	1,994.76	806.13	1,408.41	1,758.51
Sediment		630.54	282.60	845.71	309.33	681.03

Source: Primary Data Processed from Landsat Multitemporal (Dewi et al., 2016)

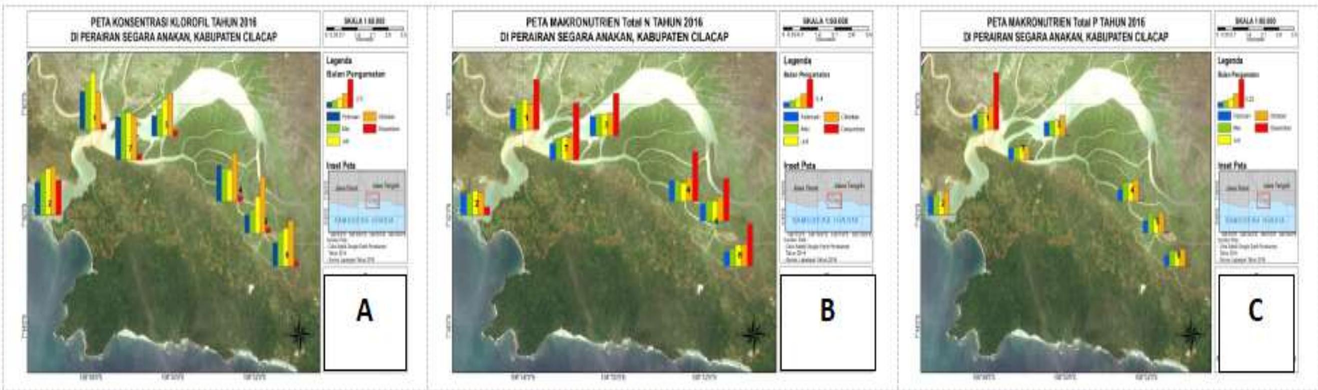

Figure 1. Thematic Map of Chlorophyll, Total Nitrogen, and Total Phosphate Analysis Results During 2016 (Dewi et al., 2017)

SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats)

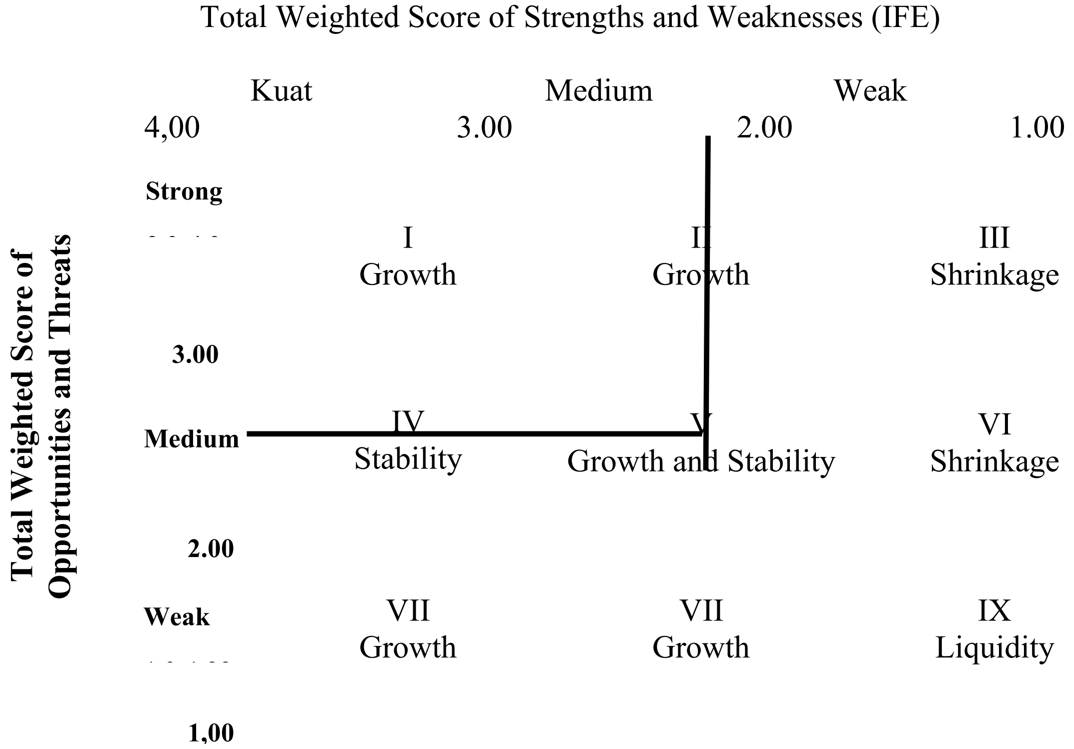

Figure 2. Results of SWOT Analysis of the Segara Anakan Lagoon Area, Cilacap Regency (Source: Processed from Primary Data)

Table 2. List of Weighted Values for Each SWOT Element of the Segara Anakan Lagoon Area Management Strategy, Cilacap Regency

Strength	Weighted Value	Weakness	Weighted Value	Opportunity	Weighted Value	Threat	Weighted Value
S1	0.60	W1	0.20	O1	0.60	T1	0.20
S2	0.30	W2	0.30	O2	0.15	T2	0.40
S3	0.45	W3	0.30	O3	0.45	T3	0.15
S4	0.20	W4	0.10	O4	0.15	T4	0.10
Total	1.55	Total	0.90	Total	1.35	Total	0.85

Source: Processed from Primary Data

Analytical Hierarchy Process (AHP) Analysis

Table 3. Criteria Weighting for Objectives

No.	Criteria	Weight
1.	Ecological (Natural) Factors	0.354
2.	Anthropogenic Factors of Community Perception and Participation	0.217
3.	Institutional Factors (Policy)	0.430
	Inconsistensy ratio	0.000

Source: Processed from Primary Data

Table 4. Aggregate Weighting of Alternatives/Priorities for Selected Strategy

No.	Alternative Strategy	Weight
1.	Strategy A	0.209
2.	Strategy B	0.241
3.	Strategy C	0.098
4.	Strategy D	0.139
5.	Strategy E	0.189
6.	Strategy F	0.123
	Inconsistensy ratio	0.003

Source: Processed from Primary Data

Table 5. Characteristics of the Spatial Approach to Phytoplankton Sampling in the Segara Anakan Lagoon Area, Cilacap Regency

No.	Characteristics	Ordinate	
1	TPI and Majingklak Port	108°48'02.4"BT	07°40'27.6"LS
2	The entrance border (West Pelawangan) of LSA which borders directly with the Indian Ocean	108°46'56.7"BT	07°41'59.0"LS
3	Cikonde and Cimeneng River Gate	108°49'47.9"BT	07°40'34.6"LS
4	Mangrove forest area	108°51'36.5"BT	07°41'44.9"LS
5	Kampung Laut Community Settlement	108°52'14.0"BT	07°42'19.5"LS
6	Ujung Alang "Mina Wisata" Conservative Area, Kampung Laut District	108°52'45.4"BT	07°42'55.4"LS
7	Cultivation Area using Floating Nets	108°48'56.0"BT	07°41'01.0"LS

Source: Processed from Primary Data

DISCUSSION

Land Conditions of the Segara Anakan Lagoon (LSA)

Based on analysis of multitemporal Landsat satellite imagery from 1978 to 2016, significant changes in land use have occurred in the LSA area. The lagoon area has shrunk by 2,703.7 hectares, equivalent to a land increase of 71.15 hectares per year over the past 38 years (Dewi et al., 2016). Table 1 shows that the lagoon area has shrunk drastically from 4,186.45 hectares (1978) to 1,482.75 hectares (2016). Meanwhile, land use for settlements, dry fields, and rice paddies has increased in several years, reflecting the conversion of aquatic areas to terrestrial areas due to sedimentation and anthropogenic activities. In particular, the increase in rice paddies and residential areas is a clear indicator of the high pressure on land use around the LSA.

To support these ecological changes, Figure 1 shows the results of spatial mapping of water quality parameters such as chlorophyll, total nitrogen, and total phosphate in 2016. The high distribution of chlorophyll at several points indicates increased primary productivity due to nutrient accumulation, which indicates the occurrence of water eutrophication (Livingston, 2001). High nitrogen and phosphate content is a consequence of organic material runoff and uncontrolled domestic and agricultural activities in the watershed area. Ayuningsih et al. (2014) stated that there is a positive relationship between nitrate and phosphate concentrations with phytoplankton abundance and chlorophyll-a levels, indicating that increased nutrients can encourage phytoplankton growth. Thus, the ecological degradation of the LSA is not only characterized by the shrinking of water bodies, but also by a decline in water quality, which directly impacts the biodiversity and sustainability of fishery resources in the area (Dewi et al., 2017).

SWOT (Strengths, Weaknesses, Opportunities, Threats) Analysis

Strategic factors influencing the impact of eutrophication in LSA waters were identified through interviews and field observations, then grouped into internal factors (strengths and weaknesses) and external factors (opportunities and threats). To map these factors, this study used a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. The SWOT analysis was based on the Internal-External (IE) matrix, which integrates two main matrices: Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE). The purpose of the IE matrix-based analysis is to determine strategic management strategies based on the influence of internal factors (strengths and weaknesses) and external factors (opportunities and threats). The results of the SWOT analysis for the LSA area can be seen in Figure 2.

According to Figure 2, the total IFE and EFE scores were 2.45 and 2.20, respectively. This score indicates that the management of the LSA area is in a "moderate" strategic position, reflecting the need for maximum utilization in its development efforts and the suboptimal utilization of external opportunities to avoid threats. Therefore, targeted strategic efforts are needed to synergistically optimize strengths and opportunities to minimize ecological impacts arising from both natural factors and anthropogenic activities. Specifically, strengths must be maximized to minimize weaknesses, and opportunities must be utilized to avoid threats. The recommended strategy in "quadrant V" aims to maintain "growth and stability" in area management from the potential impacts of eutrophication in the lagoon. Based on the IE matrix results, the recommended strategy for the development and management of the LSA is based on ecological sustainability and promotes improved community welfare.

Table 2 then presents the quantification of the SWOT elements through a weighted assessment of each factor. The strengths factor (S) has the highest score of 1.55, emphasizing the importance of the LSA's ecological characteristics as well as the role of community groups and local institutional support. On the other hand, a Weakness (W) score of 0.90 indicates the main challenges are high sedimentation and mangrove conversion. For external factors, an Opportunity (O) score of 1.35 indicates regulatory support and educational potential for the community, while a Threat (T) score of 0.85 indicates intensification of land use and weak oversight.

Furthermore, the most recommended strategy based on the total score from the SWOT interaction is the SO (Strength-Opportunities) strategy with a score of 2.90, which prioritizes leveraging internal strengths to seize external opportunities. The next strategy is ST (Strength-Threats) with a score of 2.40, followed by WO (Weakness-Opportunities) with a score of 2.25 and WT (Weakness-Threats) with a score of 1.75. The SO strategy focuses on strengthening institutions and increasing community participation to encourage conservation and sustainable management of the lagoon ecosystem. Thus, this IE analysis supports the formulation of synergistic policies between ecological and social aspects, in order to address the dynamics of environmental degradation in the LSA region (Saaty, 1980; Dewi et al., 2016). In detail, the strategy ranking of each cell generated based on the SWOT matrix can be seen as follows:

1. Rank 1 : SO strategy with a weighted value of 2.90
2. Rank 2 : ST strategy with a weighted value of 2.40
3. Rank 3 : WO strategy with a weighted value of 2.25
4. Rank 4 : WT strategy with a weighted value of 1.75

Analytical Hierarchy Process (AHP) Analysis

The LSA management strategy analysis was conducted using the Analytical Hierarchy Process (AHP) method with the assistance of Expert Choice 11 software. This method aims to prioritize strategies by developing a hierarchical structure for a complex problem, breaking it down into smaller elements based on specific criteria and alternatives (Saaty, 1980). Data collection was primarily conducted through questionnaires and in-depth interviews with key respondents to explore perceptions and preferences regarding various policy alternatives. This technique was used to assist the Cilacap Regency Government in formulating a systematic and measurable strategy for managing the impacts of eutrophication, particularly within the context of ecological sustainability and increasing local community participation. Based on this analysis, the weighting results for the criteria in the hierarchical structure, using the Expert Choice 11 program, are presented in Table 3. The institutional factor (policy) received the highest weighting (0.430), assuming the existence of effective policies and regulations, which are considered the most influential in addressing the lagoon's ecological problems. Next, the ecological factor (0.354) assumes the importance of emphasizing natural conditions such as sedimentation and habitat degradation in determining management strategies. Finally, the anthropogenic factor, community perception and participation (0.217), has the lowest weighting, but remains relevant as a supporting component in policy implementation. This indicates that institutional aspects are considered the most strategic element in formulating management policies, reflecting the importance of cross-sectoral regulation and coordination in addressing environmental issues in the area. An inconsistency ratio of 0.000 indicates a very high level of consistency in the criteria assessment, thus the analysis results can be considered valid (Saaty, 1980).

Furthermore, the priority weighting of all alternatives (six alternative strategies) against all criteria is calculated, presented in Table 4. The results show that strategy B has the highest weighting (0.241), followed by strategy A (0.209), and strategy E (0.189), while strategy C has the lowest weighting (0.098). This indicates that strategy B is the most recommended priority alternative for LSA management, likely closely related to regional policy and institutional authority aspects that are more responsive to ecological and social pressures. The low inconsistency ratio (0.003) strengthens the reliability of the strategy ranking results.

To strengthen this assumption, a spatial characteristics approach was employed in phytoplankton sampling in the LSA area, as presented in Table 5, spread across seven strategic locations within the LSA area. Sampling locations included waters directly exposed to anthropogenic activities such as ports and settlements, as well as conservation areas such as the Ujung Alang Tourism Mina. This variety of locations was designed to capture the heterogeneity of water quality and phytoplankton distribution influenced by nutrient inputs and varying environmental pressures, allowing for a comprehensive analysis of eutrophication conditions (Odum, 1971; Nielsen et al., 2004).

CONCLUSION

This study identified that Segara Anakan Lagoon (LSA) has experienced significant ecological degradation due to sedimentation from the Citanduy Watershed and anthropogenic community activities. These impacts include decreased water quality, shrinkage of the lagoon's water body, and eutrophication due to nutrient accumulation, which have reduced fisheries potential and the welfare of fishermen, encouraging a shift to the agricultural sector. Using the SWOT and AHP approaches, the priority strategy for LSA management emphasizes institutional strengthening (weighted 0.430), followed by ecological aspects (0.354) and community participation (0.217). The SO strategy was selected as the primary recommendation because it integrates internal strengths and external opportunities for sustainable management. LSA's position in "quadrant V" indicates the need for a collaborative approach to addressing existing challenges. The results of the FGD and questionnaires indicate that the participatory approach is effective in increasing community awareness and involvement. The validity and reliability of the instruments strengthen the reliability of the data, so that the resulting socio-ecological-based strategy has the potential to support sustainable conservation and socio-economic resilience of the LSA community.

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